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ABSTRACT. An annotated list of some of the major plasticizers used in processing plastic wraps for food from a toxicological point of view.

With respect to weight, plasticizers rank second among the /478* major components used in processing plastics.

The toxicity of plasticizers used in processing plastics depends upon their chemical composition.

The chief plasticizers used in this field are phosphoric esters, phthalic esters, glycolic esters, aromatic chloride derivatives, esters of fatty acids (adipates, sebacates, azelates, stearates, oleates, ricinoleates), polyacidic esters (citrate, tartrate), glycol and its derivatives, and ketones.

Polymer plasticizers are also known. They include polysebacates, polyadipates and polyazelates of glycols, polyisobutylene, butadiene-vinylcyanide co-polymers etc.

Although it is difficult to characterize plasticizers from a general, toxicological point of view, it is possible to distinguish functional groups and elements.

Thus, organic phosphates have a higher toxicity than phthalates, which are, in turn, more toxic than adipates or citrates. It is also an established fact that the physiological and toxicological properties of plasticizers of one and the same class change with an increase in molecular weight. For example, the toxicity of

* Numbers in the margins indicate pagination in the foreign text.

alcohol esters is characterized by a descending graph, no matter which group of plasticizers they belong to (phosphates, phthalates, adipates).

The toxicological properties can vary from element to element within the same group of plasticizers. Thus, tricresyl phosphate has an anti-cholinesterase effect, specific for organic phosphates, but it also induces severe polyneuritis.

The following are some data on the toxicity of certain plasticizers.

Among the phosphoric esters, the only non-toxic plasticizers are propyl glycol phosphate and 2-ethyl diphenyl phosphate. These plasticizers are allowed into the United States for use in the food wrapping industry.

Trichloroethyl phosphate, a plasticizer used in varnish and paint as well as in ethyl celluloses, nitrocelluloses, cellulose acetate, polyester resins, polyacetates and polyurethanes, has a slight anti-cholinesterase effect. The lethal dose for mice DL 50 is 1.40 g/kg body weight.

Tributyl phosphate also has a harmful effect on the organism. 1 ml/kg body weight induces an effect similar to that caused by injecting 25-75 mg/kg acetylcholine. At the same time it causes slight renal lesions and the formation of protein in the urine.

Tributyloxy ethyl phosphate, known as tributyl cellosolve phosphate, is compatible with vinyl resins, nitrocellulose and synthetic rubbers. It has a relatively low toxicity. The mean lethal dose for guinea pigs is 3 ml/kg, and death ensues after twenty hours. In view of this fact, it is not acceptable for use as a food wrap.

Tri-2-ethyl hexyl phosphate is a plasticizer and a good fire preventive agent for vinyl resins and cellulose derivatives. Its

toxicity is less than that of tributylloxy ethyl phosphate, and the lethal dose for mice is 39.8 g/kg body weight. It too is not used for wrapping food.

Triphenyl phosphate, a plasticizer for cellulose derivatives, has a slight toxic effect, causing mild polyneuritis.

Tricresyl phosphate, a plasticizer with a wide range of uses in mixtures of vinyl resins, polystyrene, chlorinated rubber, and cellulose derivatives, is also the most toxic, not only among phosphoric esters, but among all plasticizers. It causes chronic polyneuritis, accompanied by complete paralysis of the extremities. The lethal dose in dogs is 0.5 g/kg body weight.

It was used to adulterate olive oil, which it resembles in composition and appearance. It caused a notorious epidemic in Morocco in 1959, victimizing more than 10,000 persons. The most common trade names for this product are Disflamoll (Bayer), Kronitex AA (Chemicals Plastics Division Ohio-Ajex), Sindol (Celanese Corp. of America), Kolflex 50 (Kolker Chemical Corp.), PX 917 (Pittsburg Chemical Co.), TTP (Gligy).

Since it has an orthocresol nucleus, cresyl diphenyl phosphate cannot be used as a plasticizer or fire preventive agent for plastics used to wrap foods, pharmaceutical products or goods intended for large-scale consumption because it causes cerebral hemorrhages.

Phthalic esters are plasticizers with sharply reduced toxicity in contrast to phosphoric esters.

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Methyl phthalate is not used as a plasticizer for wrapping food or pharmaceuticals.

When ingested, it results in gastritis. Through hydrolysis within the organism, methyl alcohol may be produced, which is a potent poison for humans, but no such case of intoxication has yet been observed.

Ethyl phthalate has not yet been proved harmful.

Dibutyl phthalate is considered non-toxic under French law and is permitted for use in PVC mixtures in amount of 20 p. gr. plasticizer/100 p. gr. vinyl resin.

Studies on the possible cancerogenic effect of dibutyl phthalate were carried out at the Villejuif Research Institute in France, but the results were negative.

However, dibutyl phthalate has a toxic effect on the organism. Cagianet cites the case of acute dibutyl phthalate poisoning in a 23 year old laborer, who ingested 10 g of plasticizer, having mistaken it for castor oil. The poisoning is manifested in the form of a toxic neuritis (large amounts of protein, erythrocytes and leucocytes in the urine). The patient recovered after 14 hours of treatment.

Toxicological studies on cyclo-hexyl phthalate are non-conclusive. Under Italian law it can be used as a plasticizer in the food wrapping industry.

There is no proof that methyl cyclohexyl phthalate, a plasticizer for chlorinated rubber, is toxic.

Heptyl phthalate is not considered toxic. Various countries, including France, accept it as a plasticizer for use in PVC food wrapping. The same holds true for mixtures of heptyl and nonyl phthalate.

The following esters are considered non-toxic under Italian law: dioctyl and di-isooctyl phthalate, dinonylphthalate and dodecylphthalate.

Ethoxylated phthalic esters are toxic in doses of 3 ml/kg body weight. They cause ataxia and loss of reflexes.

Diocetyl and di-isooctyl adipates, and dodecyl adipate, plasticizers for vinyl polymers, cellulose derivatives and chlorinated rubber, cannot be used to wrap food, because they are slightly toxic. The lethal dose in guinea pigs for dioctyl adipate DL 50 is 20 ml/kg body weight, and death follows as a result of muscular atrophy.

No cases of human intoxication have been observed.

Dibutyl sebacate and dioctyl sebacate are considered non-toxic plasticizers and can legally be used in many countries for wrapping food and sanitary products.

Dioctyl azelate cannot be used to wrap foods because the lethal dose in mice is 8.72 ml/kg body weight. No cases of human intoxication are known.

Butyl stearate, a plasticizer for nitrocellulose varnishes and a lubricant for polystyrene, is not considered toxic. Toxicological studies of mice using doses of 32 g/kg body weight did not yield any results.

Methoxy ethyl oleate, a plasticizer for vinyl polymers and natural and synthetic rubbers, is toxic. The lethal dose DL 50 for peroral intoxication is 16 g/kg body weight.

Citric esters used as plasticizers are for all practical purposes non-toxic. They can legally be used in many countries to wrap foods.

Exceptions are triethyl acetyl citrate and stearyl and isopropyl citrates, which are lethal for cats in doses between 3.5 and 7 ml/kg body weight.

Plasticizers of the class of glycols and their derivatives have different toxicities because they are converted in different ways in the human and animal organisms. Thus, glycols usually

undergo oxidation and/or conjugation. Ethylene glycol produces a large amount of glyoxylic acid and even oxalic acid, both of which are toxic. Propylene glycol produces lactic acid, which is non-toxic, whereas its isomer, 1,3-propanediol, produces maleic acid, an enzyme inhibitor.

Polymer plasticizers, chiefly the polyesters, and especially the polysuccinates, polyazelates, polysebacates and polyadipates, have almost zero volatility, a great resistance to heat and very low toxicity. Since they are practically speaking non-toxic, they can be used in plastic mixtures used to wrap foods and sanitary products.

From the given data, it can be seen that the toxicological features of plasticizers must be considered when selecting plasticizers for plastics processing.

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